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METHOD AND SYSTEM FOR DATA COMMUNICATION IN HUMAN BODY AND SENSOR THEREFOR

TECHNICAL FIELD

The present invention relates to a method and system for transmitting data from a sensor put in the human body to the outside of the human body to collect various medical information, and particularly to a method and system for data communication in human body, wherein a current generated from the sensor flows through the human body as a conductor to transmit data to the outside of the human body.

BACKGROUND ART

Various sensors for collecting medical information in the human body have been developed and used, herein, not only a technique for collecting information in the human body but also a technique for transmitting collected information to the outside of the human body are very important.

In general data transmitting methods, there is a communication cable method applied to an endoscope which is developed for observing the stomach and intestines. In the communication cable method, a cable made of a conducting wire or an optic fiber is inserted into the human body through throat of the patient. The communication cable method has high reliability and high data quality, however, it may cause severe pain to the patient.

In order to solve the above-mentioned problem, Given Imaging LTD. in Israel has developed a capsule type endoscope called M2A. When a patient swallows the capsule type endoscope like a tablet, video data in the human body photographed by a camera of the endoscope are transmitted to an external-receiving unit, and displayed in a monitor.

However, in the capsule type endoscope, since radio wave is used to transmit a signal, power consumption is large, so that operation time is short, and receiving sensitivity is deteriorated due to interference of various electric waves from the outside of the human body. In addition, radio-transmitting apparatus such as a converter circuit for converting a video signal into a high frequency signal and an antenna for signal transmission, etc. are required, so that volume is increased and production cost is increased. Also, high frequency may be harmful to the human body.

TECHNICAL GIST OF THE PESENT INVENTION

In order to solve the above-described problems, it is an object of the present invention to provide a method and system for data communication in the human for flowing a current generated from the sensor through the human body to transmit data to the outside of the human body.

In addition, it is another object of the present invention to provide a sensor having a transmitting electrode capable of generating a current in the human body to flow a current through the human body to transmit data to the outside of the human body.

In order to achieve the above-mentioned objects, in a method for transmitting a signal from a sensor put in the human body to the outside of the human body, a method for data communication in the human body in accordance with the present invention includes the steps of generating electric potential difference between transmitting electrodes installed on the surface of the sensor; supplying a current from the transmitting electrode having higher electric potential to the inside of the human body to flow the current through the surface of the human body back into the inside of the human body and sinking the current to the transmitting electrode having lower electric potential; and inducing a voltage between receiving electrodes installed on the surface of the human body by the current flowing through the surface of the human body.

In addition, a system for data communication in the human body in accordance with the present invention includes a sensor, which is put in the human body, having transmitting electrodes for generating electric potential difference; and a receiver installed on the surface of the human body for receiving a current generated by the electric potential difference through the human body.

In addition, a sensor in accordance with the present invention includes a lighting device for irradiating the inside of the human body; a lens for focusing light incident from the inside of the human body; a CMOS image sensor for generating an electric signal from the light focused by the lens; a housing for containing the lighting device, the lens and the CMOS image sensor; and a transmitting electrode installed on the surface of the

housing to receive the electric signal.

BRIEF DESCRIPTION OF DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

In the drawings:

Figure 1 is an exemplary view illustrating a method for data communication in the human body in accordance with the present invention;

Figure 2 are perspective views illustrating several embodiments of a transmitting electrode installed to the surface of a sensor used in a system for data communication in the human body in accordance with the present invention;

Figure 3 is a sectional view illustrating the sensor of the system for data communication in the human body in accordance with the present invention; and

Figure 4 is a circuit diagram illustrating an internal construction of a CMOS image sensor of the sensor.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, the preferred embodiment of the present invention will

be described with reference to accompanying drawings.

Figure 1 is an exemplary view illustrating a method and a system for data communication in the human body in accordance with the present invention. As depicted in Figure 1, a sensor 10 placed inside the human body 1, for example, in the digestive organs transmits information of the inside of the human body 1 to a receiver 20 installed on the surface of the human body through the human body 2.

With reference to Figure 1, in the system for data communication in the human body in accordance with the present invention, a method for data communication in the human body capable of transmitting a signal from the sensor 10 inside the human body 1 to the receiver 20 placed in the outside of the human body will be described in more detail. Various information (for example, pictures of the inside of the body, PH, temperature or electric impedance, etc.) collected by the sensor 10 is converted into an electric signal by a signal processing circuit of the sensor and is applied to a transmitting electrode 11 through an output line of the signal processing circuit, and accordingly electric potential difference occurs between the two transmitting electrodes 11. Because the transmitting electrode 11 is contacted to the inside of the human body 1 (it is electrically connected with the human body through body fluids in the digestive organs), by electric potential difference between the two transmitting electrodes 11, a current 3 flows through the human body 2. The current 3 flows from the transmitting electrode having higher electric potential through the surface of the human body back into the inside of the

human body 1 and is sunken to the transmitting electrode having lower electric potential. Herein, the current flowing through the surface of the human body induces a voltage between two receiving electrodes 21, a signal transmitted from the sensor 10 put in the human body 1 can be sensed by the receiver 20 outside of the human body. The receiver 20 restores a video signal by processing the received signal, displays it on a monitor or stores it in a memory.

Figure 2 illustrate several embodiments of the transmitting electrode 11 installed on the surface of the sensor 10 of the system for data communication in the human body in accordance with the present invention. On the surface of the sensor 10, two metal plates, namely, two transmitting electrodes are formed, which are respectively connected to outlines of a signal processing circuit of the sensor.

If the two transmitting electrodes are electrically isolated and separated from each other sufficiently, the transmitting electrodes can be formed at any position of the surface of the sensor. Herein, it is preferable that the transmitting electrodes have a sensor-covering shape, namely, a three-dimensionally curved shape in order to be contacted with the inside of the human body easily.

In Figure 2, (a) shows a structure of the transmitting electrode of sensor shown in Figure 1. The transmitting electrode consists of a first electrode and a second electrode respectively surrounding the both ends of the sensor. A transmitting electrode shown in (b) consists of a first electrode surrounding an end of the sensor and a second electrode

covering the other end of the sensor as a band shape. A transmitting electrode shown in (c) consists of a first electrode and a second electrode respectively covering both ends of the sensor as a band shape. In addition, a transmitting electrode shown in (d) consists of a first electrode and a second electrode symmetrically formed along a longer axis of the sensor.

Because the transmitting electrode is exposed to the inside of the human body, it has to be made of metal having good resistance against corrosion by a reactive material such as a digestive fluid, etc. and also harmless to the human body. In the embodiments of the present invention, as metal having good corrosion resistance and harmless to the human body, SUS316L or gold is used. In addition, in order to isolate the transmitting electrodes formed on the surface of the sensor electrically, the surface of the sensor has to be a nonconductor harmless to the human body. As a nonconductor harmless to the human body, peek, polyethylene or polypropylene in a plastic group may be used. In order to improve harmlessness to the human body, parylene may be coated onto the surface of the sensor made of peek, polyethylene or polypropylene.

Figure 3 is a sectional view illustrating an internal structure of a capsule type endoscope as a sensor used for the system in accordance with the present invention. As depicted in Figure 3, the capsule type endoscope has a diameter of 10mm and a length of 20mm. A light receiving window 17 of dome shape is formed in an end of a housing forming an external shape of the capsule type endoscope, and a rectangular container 18 is formed in the other end of the housing.

Accordingly, the capsule type endoscope has a bullet shape.

In the capsule type endoscope, the light receiving window 17 which is a part for passing light is made of a nonconductor harmless to the human body and passing light. The container 18 that is a part for containing several devices also is made of a nonconductor harmless to the human body. The light receiving window 17 and the container 18 are sealed so that infiltration of a digestive fluid, etc. into the capsule type endoscope may be prevented and also leakage of substances in the capsule type endoscope into the human body may be avoided.

As depicted in Figure 3, the capsule type endoscope has the external shape of the housing consisting of the light receiving window 17 and the container 18. The container 18 includes a lighting device 12, a lens 13, a CMOS image sensor 14 and a battery 15 and a transmitting electrode 11 electrically isolated-formed on the surface of the container 18.

First, the lens 13 is arranged behind the light receiving window 17, and the CMOS image sensor 14 in which various circuits are integrated is arranged behind the lens 13. A distance between the lens 13 and the CMOS image sensor 14 is adjusted so as to focus light incident through the light receiving window 17 on the surface of the CMOS image sensor 14. Around the lens 13 and the CMOS image sensor 14, plural lighting devices 12 are arranged as donut-shape. In the embodiment of the present invention, four LEDs are used for the lighting devices 12. Non-reflection coating is performed on the inner and outer surfaces of the light receiving window 17 so that light irradiated from the lighting device 12 may pass

through the light receiving window 17 smoothly and illuminate an object. A battery 15 as power supply is arranged behind the CMOS image sensor 14. In the embodiment of the present invention, a silver oxide battery having an even discharge voltage and causing little harm to the human body is used as the battery 15.

The operation of the capsule type endoscope will be described. While the lighting devices 12 irradiate a light, the CMOS image sensor 14 captures an image of the object through the lens 13. The CMOS image sensor 14 processes the captured video signal through various internal circuits and applies the signal to the transmitting electrodes respectively connected to the two output lines 16, and accordingly the receiving electrode placed in the outside of the human body can sense the signal, as described above.

Figure 4 is a circuit diagram illustrating the CMOS image sensor 14 in order to describe the operation principles of the capsule type endoscope in more detail.

As depicted in Figure 4, the CMOS image sensor 14 includes a pixel array 100 for capturing and storing a video signal; a read circuit 110 for fetching a signal of each pixel sequentially; a coding circuit 120 for coding an output signal of the read circuit 110; a switching circuit 130 for transmitting a signal coded in the coding circuit 120 through the two output lines; a current limiting circuit 140 for adjusting a current value so as to prevent flowing of a current causing damage to the human body; a control circuit 150 for controlling the signal processing and the operation of the

lighting device 12; and an oscillating circuit 160 for determining an operational frequency.

In the embodiment of the present invention, the pixel array 100 (of 320 x 240 pixels) can capture and store video signals of high resolution. The read circuit 110 processes the stored video signals sequentially as a frame or more per 1 sec, and accordingly there is no need to have a memory disadvantageous in the cost and volume aspects. In addition, the control circuit 150 determines brightness inside the human body based on brightness of light incident to the pixel array 100 and controls the lighting device 12 to operate variably for 5 ~ 200msec. The video signals are captured by the pixel array 100 during that time. According to that, each video frame is instantly captured, and brightness thereof is better. And a PSK method that is simple and has strong tolerance against noise is used in encoding.

When the signal transmitted from the coding circuit 120 is "1", the switching circuit 130 applies + voltage to the first output line 16a and grounds the second output line 16b. When the signal transmitted from the coding circuit 120 is "0", the switching circuit 130 grounds the first output line 16a and applies a + voltage to the second output line 16b. As described-above, since the present invention transmits a signal using not the voltage size but the voltage polarity, it can be stronger to noise.

The current limiting circuit 140 serves to prevent a current more than 5mA from flowing through the human body. In the embodiment of the present invention, the current limiting circuit 140 is implemented by serially

connecting resistors to the two output lines 16 of the switching circuit 130 respectively. For example, assume that when a power voltage is 3 V the current limiting circuit 140 comprises resistors of 300 ohms serially connected to the two output lines respectively. In this case, although the transmitting electrode has a substantial short circuit because of very small resistance of the human body, current flowing through the human body does not exceed 5mA. In addition, by connecting a capacitor to each resistance in parallel, it is possible to remove a high frequency component of the signal transmitted to the human body and perform electric matching with the human body, so that signal-transmitting performance can be improved.

The signal passing the current limiting circuit 140 is applied to the two transmitting electrodes 11 and is transmitted to the outside of the human body through the human body. In the conventional frequency communication method, a high frequency signal of several hundred MHz is required, however, in the present invention, a video signal captured by the capsule type endoscope can be transmitted to the outside of the human body with a low frequency signal of 10MHz.

INDUSTRIAL APPLICABILITY

Since the present invention uses a low frequency and current instead of a high frequency through antenna when communicating with sensor in the human body, it reduces power consumption and attenuation in human body, has no effect on external interference and cause no

damage to the human body. In addition, since the invention transmits a signal using voltage polarity, it is strong to noise, and accordingly receiving sensitivity is superior.

In addition, the sensor in accordance with the present invention does not need a radio transmitter and antenna, and also does not need an additional memory because it processes video signals sequentially along the passage of time, so that a small-sized and low-priced capsule type endoscope can be provided.

CLAIMS

1. In a method for transmitting a signal from a sensor put in the human body to the outside of the human body, a method for data communication in the human body, comprising the steps of:

generating electric potential difference between transmitting electrodes installed on the surface of a sensor;

supplying a current from the transmitting electrode having higher electric potential to the inside of the human body to flow the current through the surface of the human body back into the inside of the human body and sinking the current to the transmitting electrode having lower electric potential; and

inducing a voltage between receiving electrodes installed on the surface of the human body by the current flowing through the surface of the human body.

2. The method of claim 1, wherein the electric potential difference is generated by applying an electric signal of the sensor to the transmitting electrode.

3. A system for data communication in the human body, comprising:

a sensor, which is put in the human body, having transmitting electrodes for generating electric potential difference; and

a receiver installed on the surface of the human body to receive a current generated by the electric potential difference through the human body.

4. The system of claim 3, wherein the transmitting electrode is installed on the surface of the sensor to be electrically isolated.

5. The system of claim 3, wherein the transmitting electrode is electrically connected with an internal circuit of the sensor to receive an electric signal generated from the internal circuit.

6. The system of claim 4, wherein the transmitting electrode is three-dimensionally formed.

7. The system of claim 6, wherein the transmitting electrode includes a first electrode and a second electrode which surround both ends of the sensor.

8. The system of claim 6, wherein the transmitting electrode includes a first electrode surrounding an end of the sensor and a second electrode covering the other end of the sensor as a band shape.

9. The system of claim 6, wherein the transmitting electrode includes a first electrode and a second electrode respectively covering

both ends of the sensor as a band shape.

10. The system of claim 6, wherein the transmitting electrode includes a first electrode and a second electrode symmetrically formed along a longer axis of the sensor.

11. The system of claim 3, wherein the isolator for isolating of the transmitting electrodes (the surface of the sensor) is made of one of peek, polyethylene and polypropylene.

12. The system of claim 11, wherein the isolator for isolating of the transmitting electrodes (the surface of the sensor) is coated with Parylene.

13. The system of claim 3, wherein the transmitting electrode is made of a conductive material harmless to the human body.

14. The system of claim 13, wherein the conductive material is SUS316L or gold.

15. In a capsule type endoscope put in the human body, a capsule type endoscope, comprising:

a lighting device for irradiating the inside of the human body;

a lens for focusing light incident from the inside of the human body;

a CMOS image sensor for generating an electric signal from the light focused by the lens;

a housing for containing the lighting device, the lens and the CMOS image sensor; and

a transmitting electrode installed on the surface of the housing to receive the electric signal.

16. The capsule type endoscope of claim 15, wherein the transmitting electrode is connected to an output line of the CMOS image sensor and is installed on the surface of the housing to be electrically isolated.

17. The capsule type endoscope of claim 16, wherein the transmitting electrode is three-dimensionally formed.

18. The capsule type endoscope of claim 17, wherein the transmitting electrode includes a first electrode and a second electrode which surround both ends of the housing.

19. The capsule type endoscope of claim 17, wherein the transmitting electrode includes a first electrode surrounding an end of the housing and a second electrode covering the other end of the housing as a band shape.

20. The capsule type endoscope of claim 17, wherein the transmitting electrode includes a first electrode and a second electrode respectively covering both ends of the housing as a band shape.

21. The capsule type endoscope of claim 17, wherein the transmitting electrode includes a first electrode and a second electrode symmetrically formed along a longer axis of the housing.

22. The capsule type endoscope of claim 15, wherein the surface of the housing is made of one of peek, polyethylene and polypropylene.

23. The capsule type endoscope of claim 22, wherein the surface of the housing is coated with Playlene.

24. The capsule type endoscope of claim 15, wherein the transmitting electrode is made of a conductive material harmless to the human body.

25. The capsule type endoscope of claim 24, wherein the conductive material is SUS316L or gold.

26. The capsule type endoscope of claim 15, wherein the front of the housing is formed as a dome-shaped light receiving window and the

rear of the housing is formed as a rectangular container.

27. The capsule type endoscope of claim 26, wherein the light receiving window is made of a material harmless to the human body and passing light.

28. The capsule type endoscope of claim 26, wherein non-reflection coating is provided on the inner and outer surfaces of the light receiving window.

29. The capsule type endoscope of claim 15, wherein the lighting device is an LED.

30. The capsule type endoscope of claim 29, wherein the LED has a variable operation time within 5ms ~ 200ms.

31. The capsule type endoscope of claim 15, wherein the CMOS image sensor includes:

a pixel array for converting a video signal into an electric signal and storing the electric signal;

a read circuit for fetching the electric signal of the pixel array sequentially;

a coding circuit for coding an output signal of the read circuit;

a switching circuit for changing polarity of an output line according

to the coded signal;

a current limiting circuit for restricting flowing of a current more than a certain value;

a control circuit for controlling operation of the lighting device and operation of the CMOS image sensor; and

an oscillating circuit for generating a pulse.

32. The capsule type endoscope of claim 31, wherein the pixel array converts a video signal into an electric signal and stores the electric signal while the lighting device irradiates.

33. The capsule type endoscope of claim 31, wherein the read circuit fetches and processes the electric signal sequentially while the lighting device is turned off.

34. The capsule type endoscope of claim 31, wherein the coding circuit performs PSK coding.

35. The capsule type endoscope of claim 31, wherein the switching circuit changes polarity of the output line by making a current flow from the first electrode to the second electrode when the coded signal is "1" and making a current flow from the second electrode to the first electrode when the coded signal is "0".

36. The capsule type endoscope of claim 31, wherein the current limiting circuit maintains the current to be not greater than 5mA.

37. The capsule type endoscope of claim 31, wherein the current limiting circuit is constructed by connecting resistance serially to output lines of the switching circuit respectively.

38. The capsule type endoscope of claim 37, wherein the current limiting circuit further includes a capacitor respectively connected to the resistance in parallel.

39. In a method for transmitting a signal from a capsule type endoscope put in the human body to the outside of the human body, a method for data communication in the human body, comprising the steps:

generating electric potential difference between transmitting electrodes installed on the surface of a capsule type endoscope;

supplying a current from the transmitting electrode having higher electric potential to the inside of the human body to flow the current through the surface of the human body back into the inside of the human body and sinking the current to the transmitting electrode having lower electric potential; and

inducing a voltage between receiving electrodes installed on the surface of the human body by the current flowing through the surface of the human body.

40. The method of claim 39, wherein the capsule type endoscope makes a current flow from one transmitting electrode to the other transmitting electrode when a signal to be transmitted is a digital signal "1" and makes a current flow from the other transmitting electrode to one transmitting electrode when a signal to be transmitted is a digital signal "0".

41. The method of claim 39, wherein a size of the current is limited by connecting resistance serially to the transmitting electrode respectively.

42. The method of claim 41, wherein a capacitor is connected to each resistance in parallel.

FIG. 1

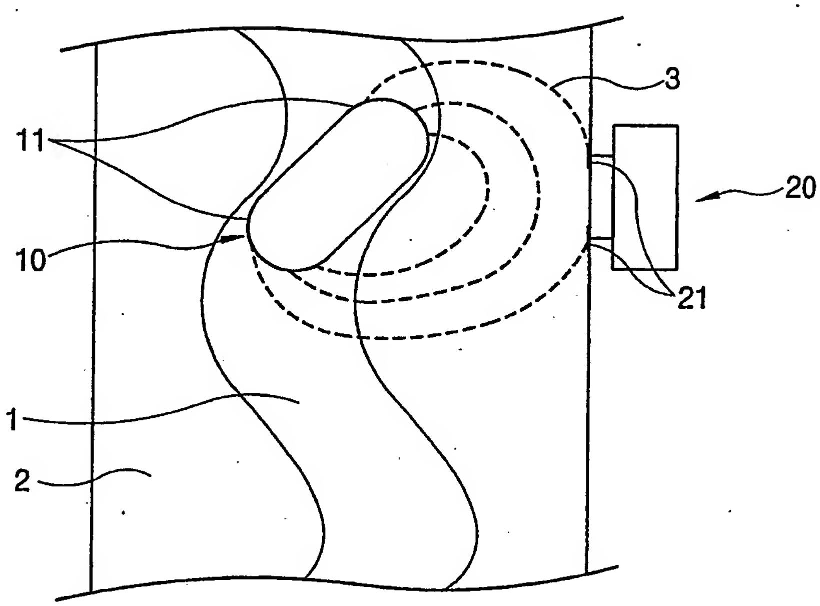


FIG. 2a

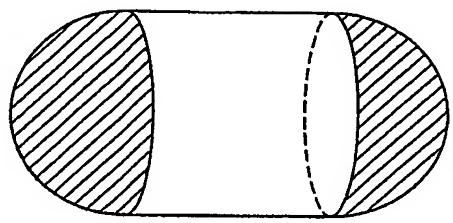


FIG. 2b

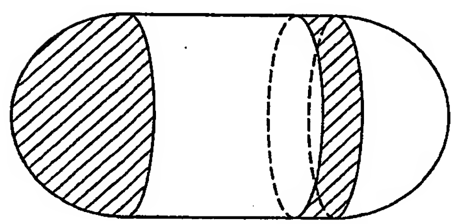


FIG. 2c

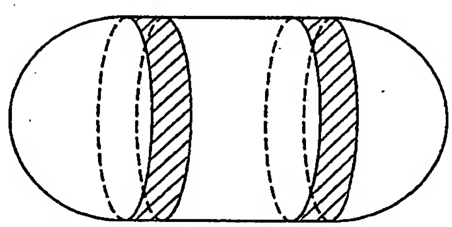


FIG. 2d

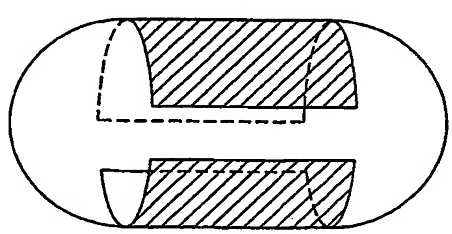


FIG. 3

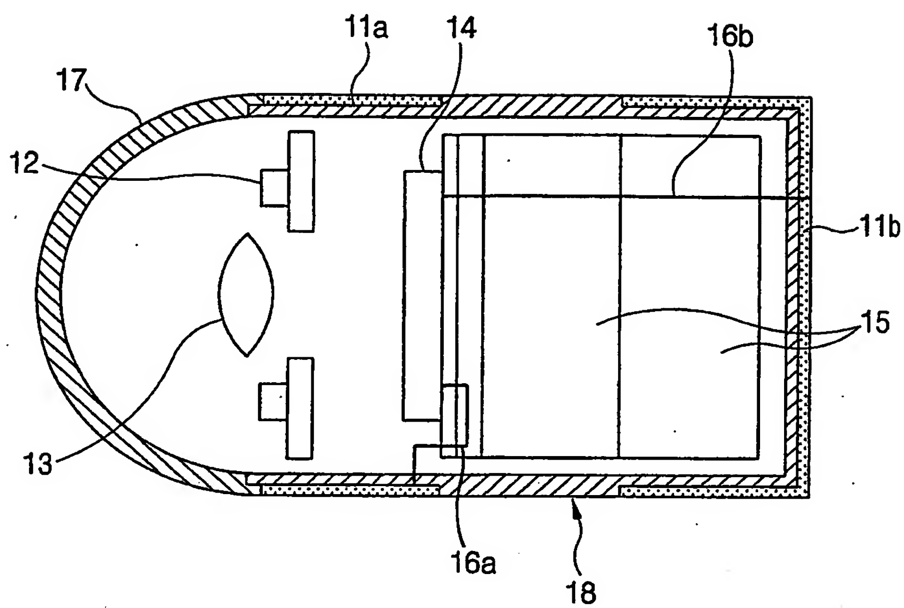
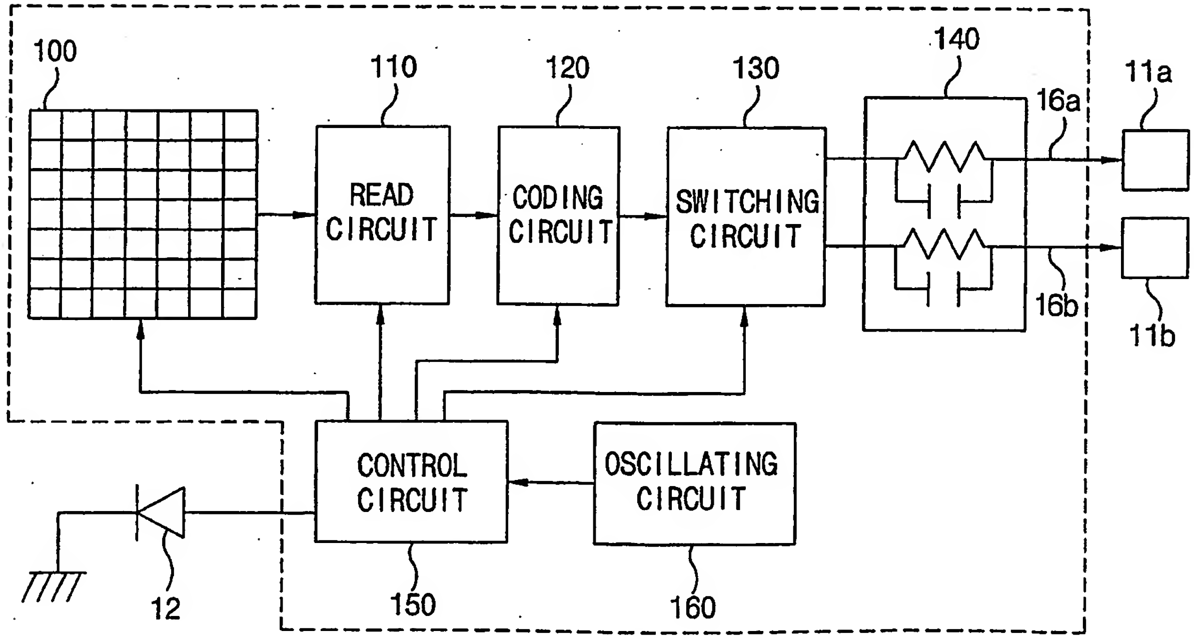

11a
14
16b
17
12
11b
15
13
16a
18

FIG. 4


100
110
120
130
140
11a
16a
READ CIRCUIT
CODING CIRCUIT
SWITCHING CIRCUIT
16b
11b
CONTROL CIRCUIT
OSCILLATING CIRCUIT
12
150
160